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ITS CONTROL IN BRITISH COLUMBIA

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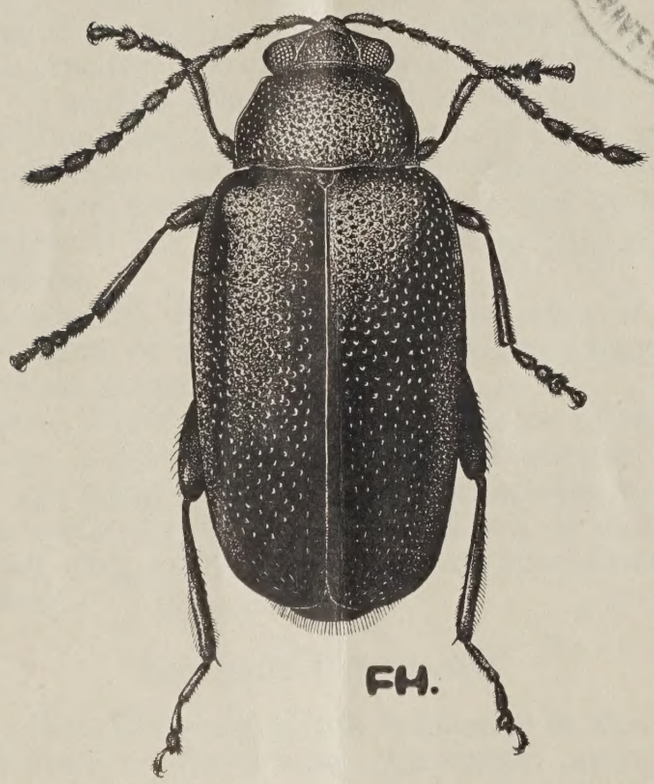

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THE CABBAGE FLEA-BEETLE AND ITS CONTROL IN BRITISH COLUMBIA

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INTRODUCTION

The study of the life-history and control of the cabbage flea-beetle, *Phyllotreta albionica* Lec.,* was undertaken at the request of the Dominion Entomologist, in 1923, in response to numerous inquiries from farmers and gardeners in the Lower Fraser valley, British Columbia.

The cabbage flea-beetle belongs to a group of small, very active, leaf-eating beetles, which have the hind legs developed in such a way that they are able to jump somewhat after the manner of fleas. Early observations showed that while there are three species of flea-beetles of economic importance in the Lower Fraser valley, the damage to cruciferous crops is caused only by one species, namely the cabbage flea-beetle. The two other species have at times caused damage to their respective host plants but are not so important at the present time as the species attacking cruciferous crops. The three species have been frequently confused by growers, who considered that the hop flea-beetle was responsible for all flea-beetle injury. The following brief notes will assist the grower to separate the three species.

The cabbage flea-beetle, *Phyllotreta albionica* Lec., is shining, metallic-green in colour, one-eighth of an inch long and without hairs on the back. It feeds only on cruciferous plants.

The hop flea-beetle, *Psylliodes punctulata* Mels., is of the same size as the cabbage flea-beetle, but is bronze in colour, and also without hairs on the back. It feeds on mangel, hop, hemp, rhubarb, nettle and certain other plants.

The potato flea-beetle, *Epitrix cucumeris* Harris, is dull bronze in colour, one-twelfth of an inch long, and covered with fine short hairs. Its food plants are potato and tomato.

ECONOMIC IMPORTANCE

Crops infested.—The following plants belonging to the family *Cruciferae* have been noted as hosts of the cabbage flea-beetle: turnip, radish, cabbage, cauliflower, kale, brussel sprouts, candy-tuft, species of *Alyssum* and *Arabis*, both wild and cultivated, and various weeds such as shepherd's purse and hedge mustard.

The favourite host plants are undoubtedly turnip, both rough and smooth-leaved, and radish. Pickling cabbage and brussel sprouts, are not much eaten, especially when other hosts are present. The only non-cruciferous plant found attacked is the garden nasturtium belonging to the family *Tropæolaceæ*.**

Nature of injury.—The first injury noticed is in early spring when seed leaves are damaged, small holes appearing in the leaf surface. This is followed by the entire destruction of the seed leaves, resulting in the death of the young plants. Reseeding is generally resorted to, but unless a wet, cool spell of weather intervenes retarding the feeding of the beetles, a second, and even a third seeding may be similarly destroyed.

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* In the planning of this investigation, the author was assisted by the late Mr. R. C. Treherne.

** Mustard oils are present in plants of this family as well as in the *Cruciferae* and this is presumably the reason why this insect as well as the imported cabbage worm, *Pieris rapae* L., feeds on both plants.

The insect is undoubtedly most destructive in early spring, but when abundant it will continue to do damage up to the end of June, causing the young plants to make slow progress owing to the injury to the leaves.

The beetles become most numerous during August and, although the host plants by that time are nearly mature, the insect is occasionally so abundant that as many as five hundred beetles may be present on one plant, and even the largest leaves may be reduced to shreds. In such circumstances late cauliflower or kale may be quite spoiled.

FIG. 1. Seed leaves of cabbage showing injury from beetle feeding. (X4). FIG. 2. Leaf of cabbage showing beetles feeding and injury (Original).

DESCRIPTION OF THE LIFE STAGES

The egg.—The eggs are very small and oval, 0.5 mm. in length and golden yellow in colour. They are usually found in groups of from ten to twenty, in the soil at the base of the host plants.

The larva.—The larva is a slender, dirty-white grub, with the head and anal plate brown. When full-grown it measures 5 mm. ($\frac{1}{5}$ inch) in length, by less than 1 mm. ($\frac{1}{25}$ inch) in width. It is quite active and may be found by careful search at the roots of the host plants, at a depth of from two to six inches.

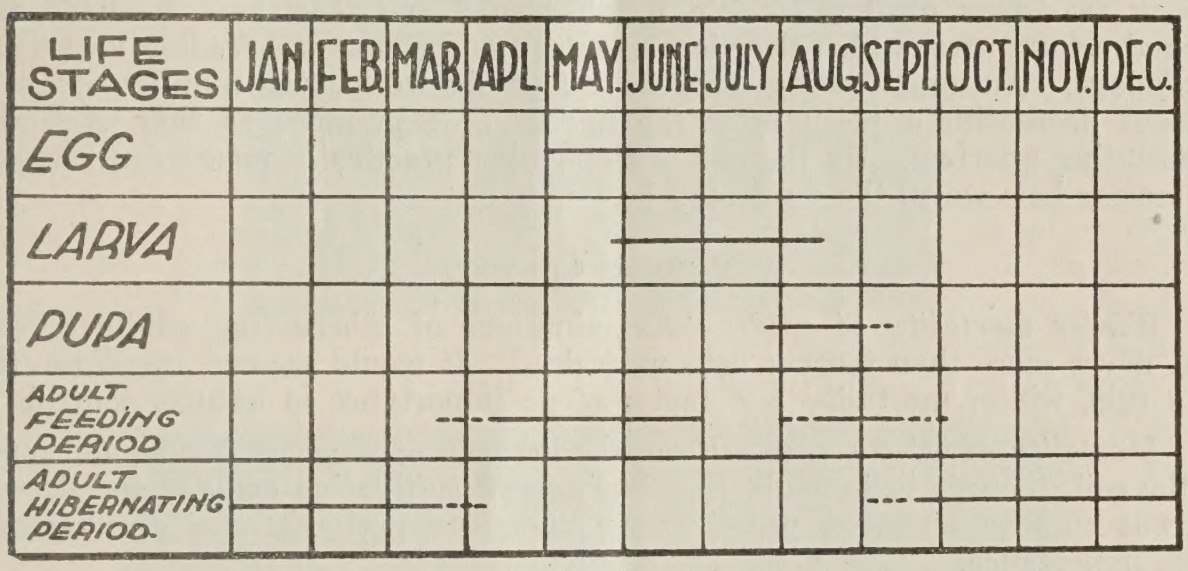
The pupa.—The pupa is pure white, and measures from 2.5 to 3 mm. in length by 1·5 mm. in width. It is found singly in small earthen cells in the soil around the roots of the host plant.

The adult.—The adult beetle is shining, metallic green in colour, and measures rom 2·5 to 3·5 mm. long. It is very active, leaping a distance of from two to three feet when disturbed, and flying freely on hot days during the mating season. The hind legs are strongly developed for leaping.

Life-history and Habits

The beetles emerge from hibernation in spring and feed for about three months. Mating and egg-laying take place during late April and May, after which the adult beetles gradually die off, until by the end of June few are present. During June and July the larvae develop in the soil at the roots of the plants on which the beetles fed. The larvae transform to beetles, which commence emerging from the soil about the end of July, and go into hibernation about September 15.

Hibernation.—A study of the hibernating quarters of the beetles indicates that accumulations of dry leaves under hedges or shrubs, in the bush, or along fence rows, are generally chosen. When these situations are not adjacent to the feeding grounds, the beetles will travel, readily, a quarter of a mile or more in their search for suitable winter quarters. A favourite hibernating place at Agassiz, B.C., was under a Deutzia hedge adjacent to a vegetable garden, as many as fifty individuals being recovered from a single bucketful of leaves.



Life history chart of Cabbage Flea-beetle (Original).

Spring activity.—The beetles emerge from hibernation in late March and early April. They feed only in warm dry weather and do not become very numerous during the first month. During spells of dull weather they cease feeding and disappear.* The beetles of this generation reach their greatest abundance in the garden in May, their numbers decreasing during June, until by the end of that month, egg-laying having been completed, they gradually die off.

The beetles start mating towards the end of April and may be seen in pairs on the leaves during the middle of the day. Copulation lasts from two to five minutes and the pre-oviposition period from five to ten days.

The eggs are laid around the base of the plants on which the adults feed, at a depth of from one to two inches beneath the surface of the soil. An average of sixty eggs is laid per female, in batches of from fifteen to twenty during a period of three weeks. The incubation period of the eggs has not been definitely ascertained, but it probably varies from fifteen to twenty-one days according to conditions.

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* It was presumed that they hid under lumps of earth or in the soil, where other species of flea-beetles are supposed to go, but during cool spells only a very few could be found and these were on the undersides of the leaves. Where the majority go has not yet been determined.

Larval activity.—The larvae feed on the roots of the hosts on which the beetles feed. Their depredations do not appear to cause appreciable damage to the plants and, therefore, the larvae probably cannot be considered as harmful. By careful digging they may be found around the roots of the host plants at a depth of from two to six inches, at any time from the middle of May to the end of July.

The active feeding period lasts, approximately, four weeks, after which the larvae enter the prepupal stage, lasting from ten to twelve days. This stage is characterized by the larva becoming sluggish in movement and by the body gradually becoming shorter and broader until transformation into the pupal stage is complete.

The pupal stage lasts eleven days on the average. The pupae are pure white in colour and occur in smooth earthen cells about 4 mm. in diameter. They generally occur nearer the surface of the soil than the larvae and when disturbed in their cells they wriggle freely.

Late summer activity of the beetles.—The beetles commence emerging early in August and at first are pale in colour. They remain in the surface soil for one or two days until the chitin has hardened and they have assumed their normal colour, after which they leave the soil and commence feeding voraciously on foliage. Autumn feeding lasts for about six weeks, the number of beetles present decreasing rapidly after the middle of September as they seek their hibernating quarters. By the end of September practically none are to be seen, no matter how warm the days may be.

Natural Control

Winter mortality of adults.—Examinations of hibernating adults revealed that never more than ten per cent were dead. It would appear, therefore, that, as a rule, winter mortality is a factor of no importance in natural control.

Mortality of other stages.—From the location of the eggs, larvae and pupae, in the soil, there is little doubt that hoeing and cultivation exposes and destroys a great number, and such practices are, therefore, probably a control factor of some importance.

Parasites.—In 1923, a few small, parasitic, braconid insects were noticed amongst the beetles in the field. Some of these were captured and confined with beetles in cages. They were seen to oviposit in the beetles, the operation being a very interesting one. The parasite cautiously approaches the beetle when at rest and strokes the latter with its antennae. If the beetle does not jump, the fly edges around to the side of its host, thrusts forward the tip of its abdomen between its legs and stabs the beetle on the under part of the thorax with its ovipositor. The beetles are usually impatient at the approach of the fly, necessitating repeated attempts before a successful stab can be made. The grub of the parasite after developing in the body of its host emerges from the beetle, resulting in the death of the latter, and spins a small white cocoon nearby. The life cycle of the parasite is approximately three weeks and the females are parthenogenetic, commencing to oviposit one day after emergence. The parasite, *Perilitus epitricis* Vier., was never found to be numerous. It was not observed at all in 1926.

Artifical Control

When this investigation was started, a considerable number of different substances including the usual remedies recommended for this class of insect, were experimented with. It was soon discovered that, for various reasons, none of these materials give satisfactory control, the chief reason for which is that all have the defect of being too soon removed from the smooth glaucous surface

FIG. 3. Distributing nicotine dust from a hand gun; FIG. 4. Rotary duster discharging nicotine dust (Original).

of cruciferous plants by heavy dews and rain. Later the addition of various stickers was found to improve the adhesive quality of the sprays, but they were still unsatisfactory and the beetles continued to do much damage.

The cabbage flea-beetle appears to be a most persistent feeder, and when hungry is not deterred even by heavy coatings of Bordeaux mixture or other substances, feeding on any small areas; either on the upper or lower surface of the leaves that it finds free from spray.

The following is a brief statement of the various materials experimented with: Bordeaux mixture used without the addition of a sticker had a deterrent effect against the beetle lasting two days. A series of Bordeaux mixture sprays were also tried with one of the following stickers added to each solution: skim milk, liquid soap, whale oil soap, laundry soap, molasses and powdered resin. The stickers improved the adhering qualities of the Bordeaux mixture, but its deterrent quality proved unsatisfactory after the expiration of four days. Iron sulphate used alone or in combination with Bordeaux mixture was found to have a deterrent effect on the beetles lasting from three to four days. Kerosene emulsion, sand impregnated with kerosene, and a one per cent solution of creosol were also tried, but gave unsatisfactory results.

From the above experiments it was found that even the best deterrent materials are effective for only four days, and as the use of these would necessitate spraying twice a week, they were rejected as unsatisfactory.

Lead arsenate and whale oil soap sprays proved unsatisfactory. Extensive trials with nicotine sulphate and whale oil soap yielded only negative results. Copper arsenate and lead arsenate, used in dust form with hydrated lime, both with and without flour added as a sticker, gave unsatisfactory results, and so, also, did sodium fluosilicate and copper carbonate dusts. Corrosive sublimate although effective against larvae of the beetle in cage experiments was found not to be practicable for use under field conditions. In addition, certain contrivances for mechanical trapping of the adults also proved unsatisfactory.

Nicotine dusts.—In the autumn of 1925 a two per cent nicotine dust was used in the field with surprising results. The dust was discharged from a rotary hand duster over some kale plants heavily infested with flea-beetles. All beetles hit by the dust fell to the ground, wriggled for a few seconds, many biting pieces of earth, and then lay still. Some hundreds were collected and brought into the insectary, where after twenty-four hours only about five per cent recovered. This success was followed by extensive experiments in 1926, confirming and elaborating these results.[1]

The nicotine sulphate was mixed with hydrated lime at strengths of one, two, three and four per cent actual nicotine. One per cent nicotine dust was found to be too weak, and under the optimum conditions only a seventy-five per cent kill was obtained. Four per cent dust was abandoned on account of the high cost and difficulty in mixing such high percentages of moisture.

Two per cent dust usually gave a good kill with a shade temperature of 80° Fahr. or over, but as this degree of heat is not often attained, dust at this strength cannot be recommended. Three per cent dust is much more constant in killing power and less dependent on high temperature. All dustings made with this strength at a shade temperature of 65° Fahr. or over proved satisfactory.

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[1] In connection with experiments conducted in 1926, Mr. H. H. Ross, seasonal assistant, rendered valuable assistance.

Recommendations

To destroy the cabbage flea-beetle, nicotine dust at a strength of three per cent should be used on warm days. This dust kills by the rapid liberation of nicotine fumes, which are breathed in by the beetles, causing instant paralysis. The nicotine is very volatile when mixed with lime, especially in warm weather, and the dust should, therefore, be mixed fresh for each application or else kept in an air-tight container. The dust may be purchased in air-tight cans ready for use from manufacturers of spray materials, or the ingredients, nicotine sulphate and hydrated lime, may be purchased separately and mixed at home.

A considerable saving in time and material may be effected when dusting if, when the main crop of cabbage or kale, etc., is sown, a row of swede turnips is also sown amongst the main crop. The beetles much prefer these turnips to any other cruciferous plant and congregate in immense numbers thereon, where they may be destroyed with great saving, as it may not be necessary to dust the whole crop.[2]

Mixing the dust.—The usual apparatus used in mixing the dust consists of a small barrel placed horizontally on a stand so that it may be revolved by hand. In the side of the barrel a hole about six inches square is cut and a hinged lid attached. The requisite quantity of lime is placed in the barrel and the nicotine sulphate is poured over the lime. A few round stones about the size of golf balls should also be put in the barrel to prevent the lime from caking and to ensure even mixing.

The barrel should then be revolved for about five minutes until the nicotine is thoroughly mixed and no lumps of lime remain. When the mixing has been completed the dust may be poured directly into the duster or into an air-tight can and used as needed. For small quantities of less than two pounds, the dust may be mixed in an ordinary kitchen flour sifter, but when so little is needed it is easier to purchase the dust ready mixed.

Strength to use.—For the cabbage flea-beetle three per cent dust is recommended.* The strength of the dust is estimated on the actual nicotine content and not by the percentage of nicotine sulphate. To prepare fifty pounds of three per cent dust, therefore, three and three-quarter pounds or 2·4 imperial pints (three U.S. pints) of forty per cent nicotine sulphate should be added to fifty pounds of hydrated lime. For smaller quantities it is convenient to mix five fluid ounces of nicotine sulphate with each five pounds of lime.

When to dust.—The dusting should be performed on a sunny day when the temperature in the shade is 70° F. or over. Dull or wet days are unsatisfactory as the temperature then is generally too low for the dust to kill the insects. The number of applications necessary varies greatly under different circumstances, but probably three applications in the spring and one or two in August will keep the beetles down to negligible numbers. Migrations from untreated plots necessitate more dusting than would be the case where all adjacent cruciferous crops are treated simultaneously.

Quantities to use and cost.—Nicotine dust is easily and quickly applied. One pound of three per cent dust costs about eleven cents and covers from three hundred to nine hundred feet of row according to the size of the plants and the

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[2] My attention was called to this point by Mr. J. J. Woods, assistant in horticulture at the Agassiz Experimental Farm.

* Although one per cent and two per cent dusts will readily kill various species of aphis, flea-beetles are more resistant and require stronger fumes to destroy them.

type of dusting apparatus used. One acre of turnips, or similar crop, requires from sixteen to thirty pounds of dust and costs from $1.75 to $3.30 for material. The labour cost is trifling as an acre may be dusted in an hour.

Type of machine and method of application.—There are several types of apparatus on the market for the application of dusts. For small garden plots the plunger type of dust gun, costing about $1, is sufficiently large and does good work. These guns hold about one-half of a pound of dust. For larger areas the rotary or bellows type of duster is preferable. These cost about $20 and hold from five to ten pounds of dust. With vigorous turning or pumping the dust may be applied as fast as a man can walk.

One row should be dusted at a time, the gun being held about two feet above the plants and care being taken not to unnecessarily disturb the beetles before discharging the dust. The row should be approached facing the sun so that it is possible to envelop the beetles in the cloud of dust before they become frightened and leap off. As many beetles as possible should be hit by the dust which sticks to them, death being caused by the liberated fumes. Shaking the dust from a cheesecloth bag is useless as the dust does not adhere to the beetles, which are simply frightened off.

Summary

Of several species of flea-beetle causing damage in the coastal region of British Columbia, the cabbage flea-beetle is the most important. It has increased in numbers greatly with the advance of agriculture and annually causes much damage by destroying the leaves of cruciferous crops, especially in early spring. There is only one generation each year, the winter being passed in hibernation by the adult beetles. Eggs are laid in the soil in May and the larvae feed on the roots of the same host plants attacked by the beetles. The life cycle occupies approximately seventy-seven days.

The usual remedies, including various deterrents and stomach poisons, have been found ineffective against this species, under coastal weather conditions in British Columbia. Nicotine dust used at a strength of three per cent has been found to be an efficient remedy. This substance is easily and cheaply applied, but as the application of dusts is not yet commonly well understood the necessary information is presented herewith.

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